100-Kilometer-Scale Regions of Primordial Flotation Crust may be Accessible in Hertzsprung Basin

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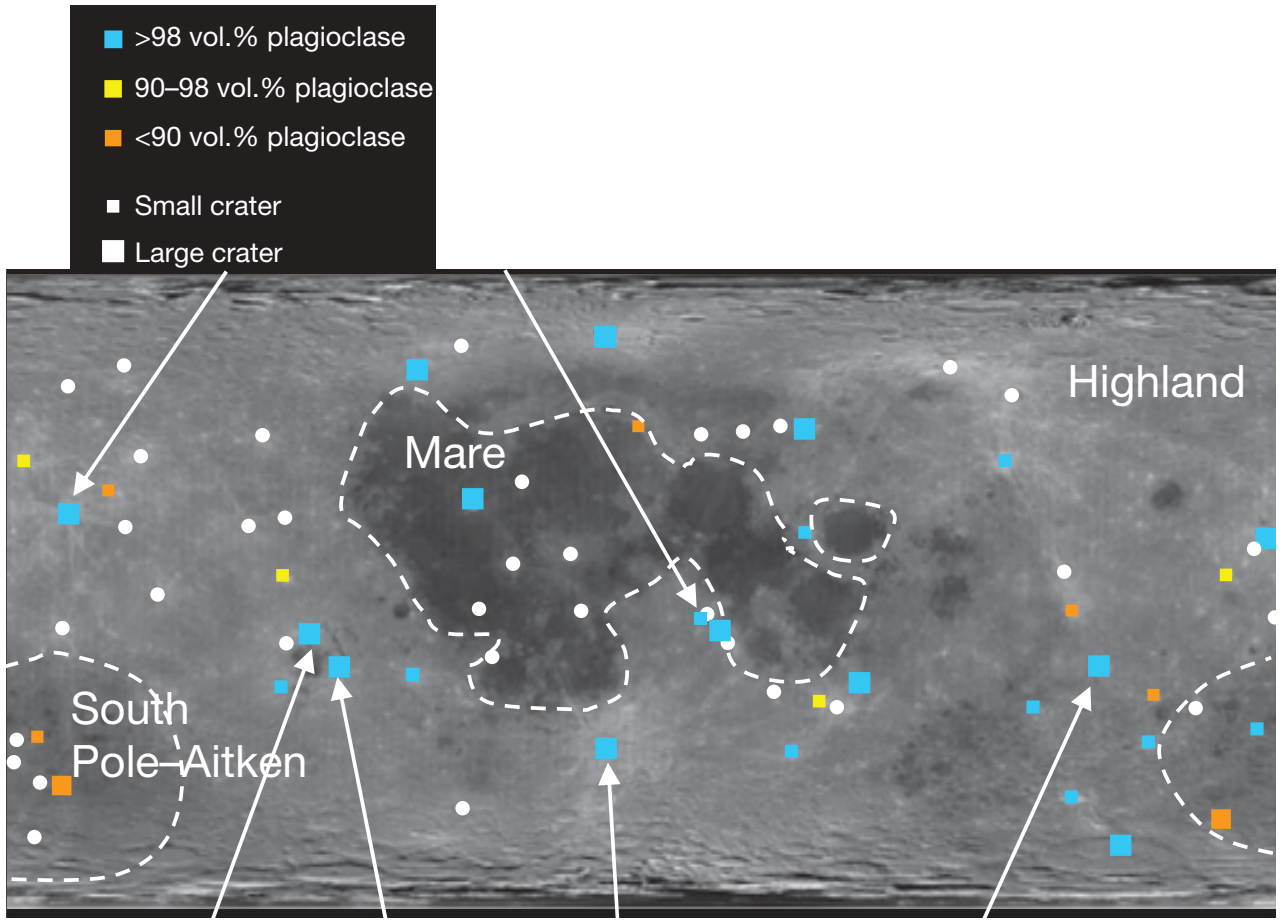
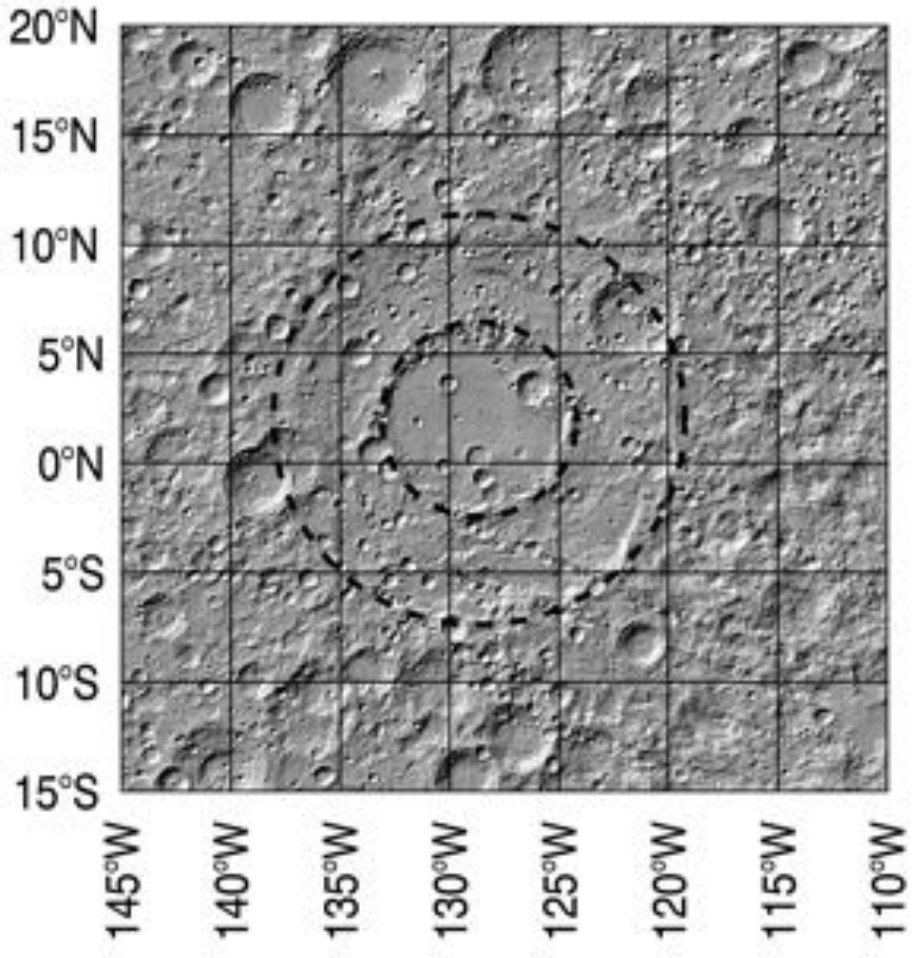
Nearly pure anothosite outcrops occur globally



Ohtake, M. et al (2009) *Nature,* **461**, 236–240.

- The anorthositic nature of the FHT was first postulated on the basis of ferroan anorthosites found in the Apollo samples suite.
- This GMO scenario assumes that the Moon was once mostly or completely molten and that the primary lunar crust formed from floatation of cumulates as the melt cooled.
- Recently, spectral reflectance measurements have identified signatures of nearly pure anorthosite (PAN) across the lunar surface but primarily in the FHT.
- The association between PAN and material within and excavated by impact basins has led to the hypothesis that a subsurface layer of nearly pure plagioclase exists tens of kilometers beneath the lunar surface.

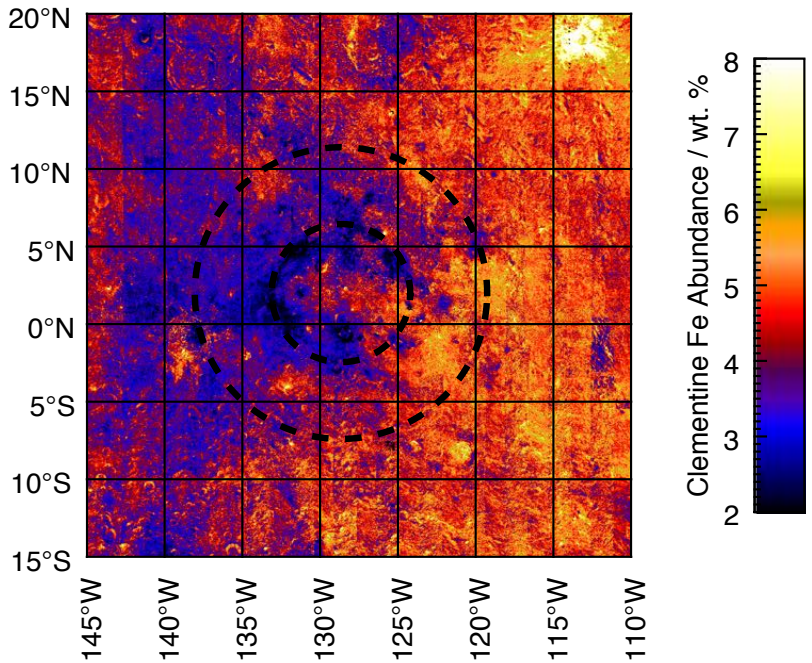
Hertzsprung basin



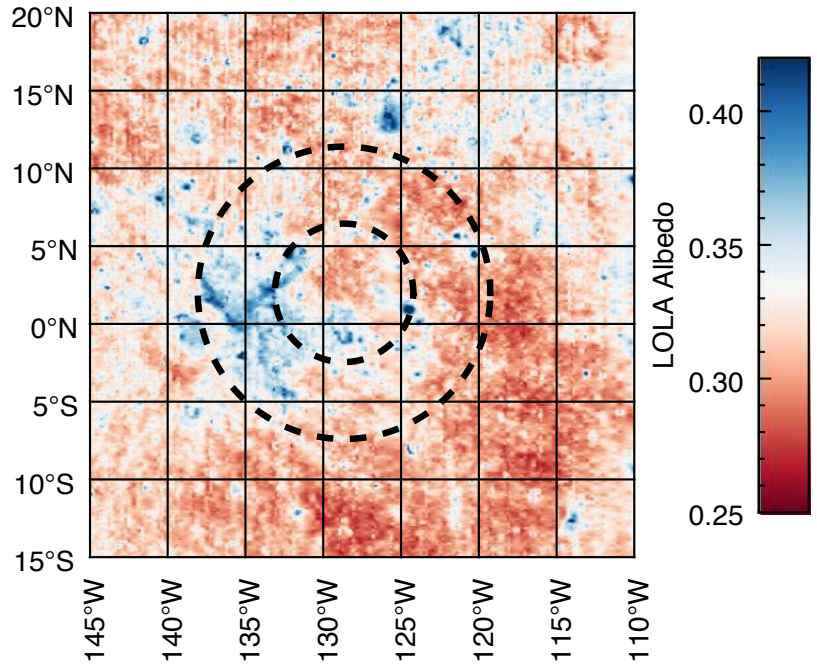
- Hertzsprung is a well-preserved impact basin on the Moon's farside at 2°N, 128°W.
- It contains two clear rings, the main rim of 570 km diameter and an inner ring of 270 km diameter.
- From the crater's morphology it is estimated that the impact excavated material from the top half of the 80 km thick crust.

Hertzsprung Basin – An extremely FeO poor peak ring and broad high albedo region

Clementine FeO abundance



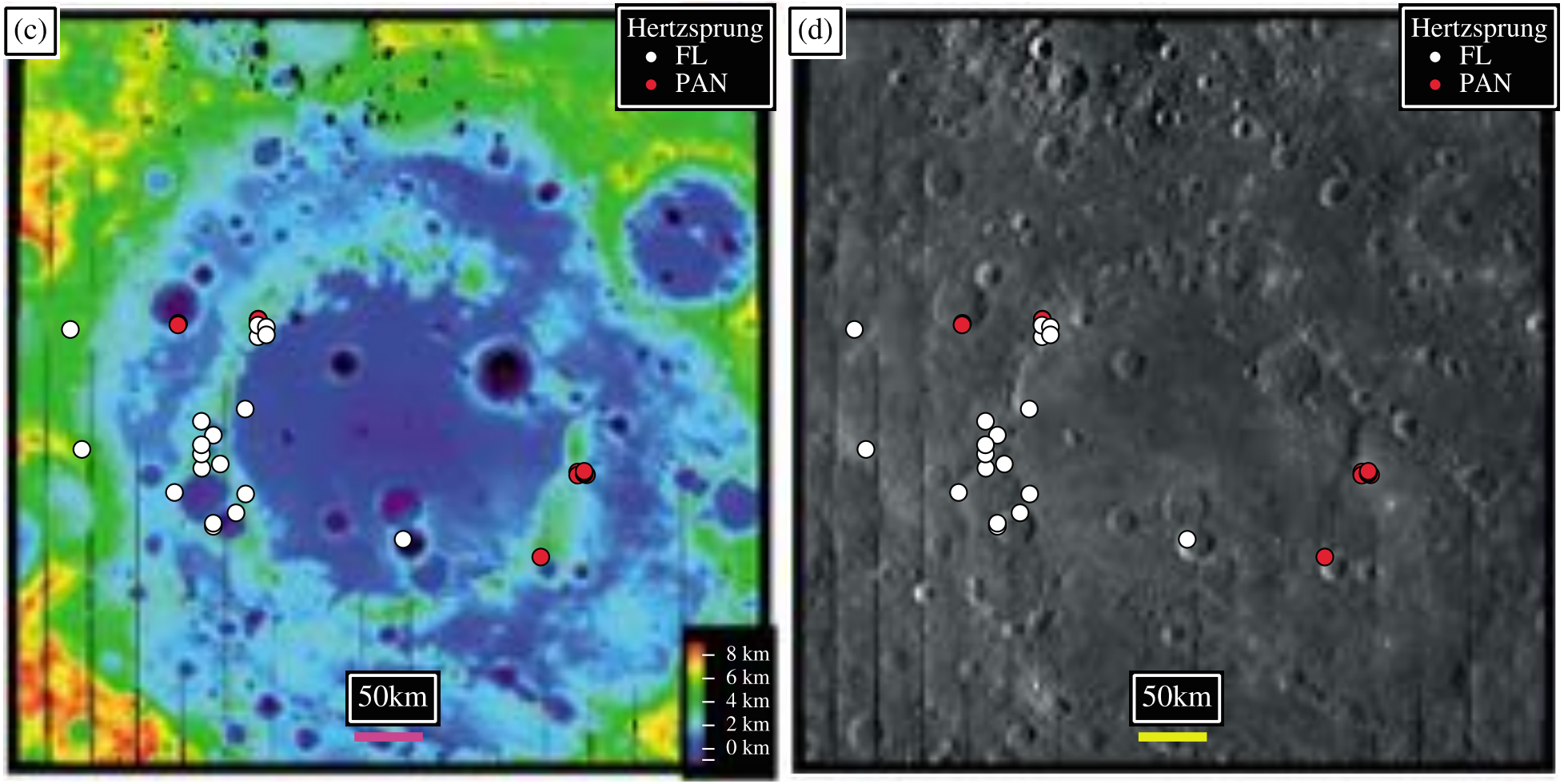
LOLA 1064 nm albedo



Clementine spectral data has shown that the ejecta from Hertzsprung is unusually feldspathic and that the inner ring massifs contain almost completely iron free regions.

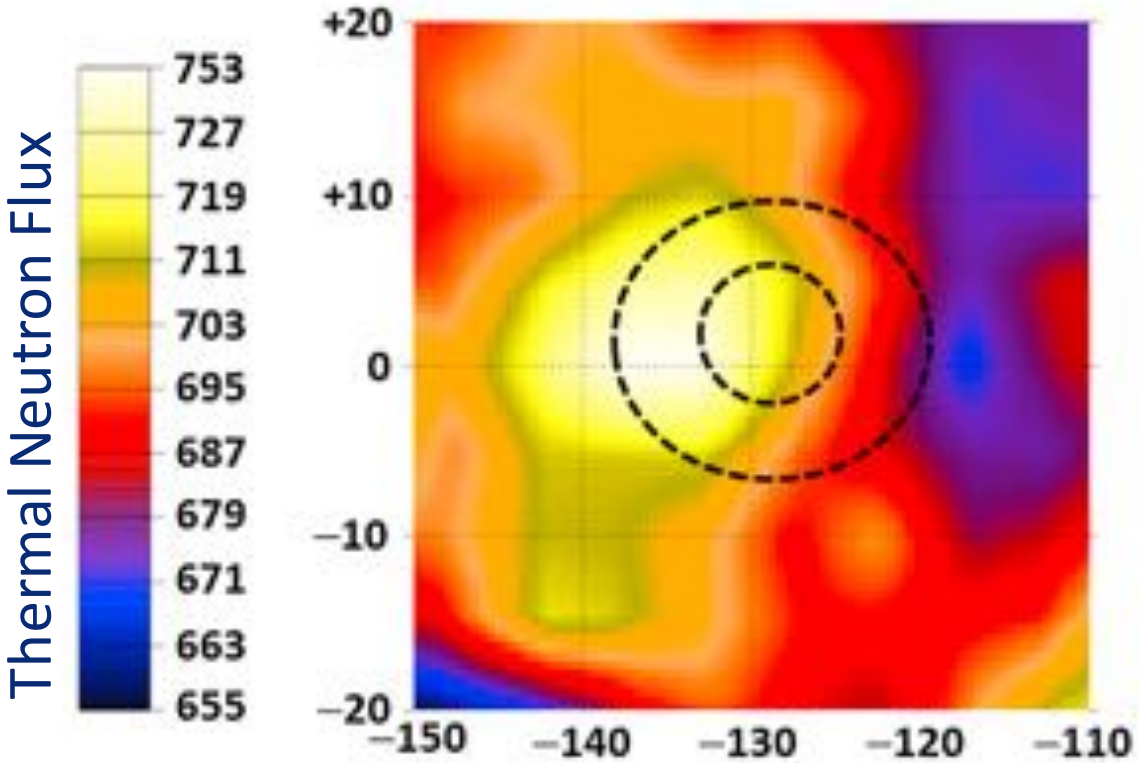
These Fe free regions were interpreted as outcrops of nearly pure anorthosite.

PAN outcrops at Hertzsprung basin



Yamamoto, S., et al. (2015), **JGR (Planets)**, *120*, 2190–2205

Thermal neutrons reveal Hertzsprung to be Fe and REE poor



Peplowski, P. N., and D. J. Lawrence (2013), **JGR (Planets)**, 118, 671–688

- Thermal neutron emissions is a proxy for the bulk concentration of neutron-absorbing elements, including Fe, Ti, and the rare earth elements (REEs) Gd and Sm.
- Flux at Hertzsprung implies > 85 % Ca-rich plagioclase.
- Neutron signal known to be blurred due to the relatively broad response function.

How can image reconstruction help?

$$\text{Data} = \text{Image} * \text{PSF} + \text{Noise}$$

How can image reconstruction help?

Data = Image ✻ PSF + Noise

Pixon Reconstruction:

- Improve spatial resolution and suppress noise.
- Bayesian image reconstruction technique that aims to find the simplest image consistent with data.
- Minimize statistic based on the autocorrelation of the residuals to avoid spurious features.

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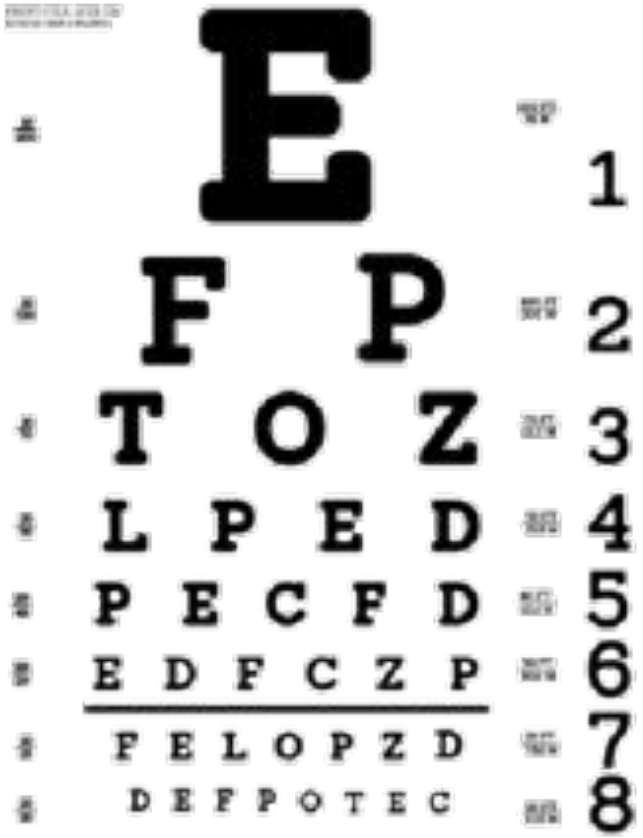
A demonstration and impromptu eye test

Image



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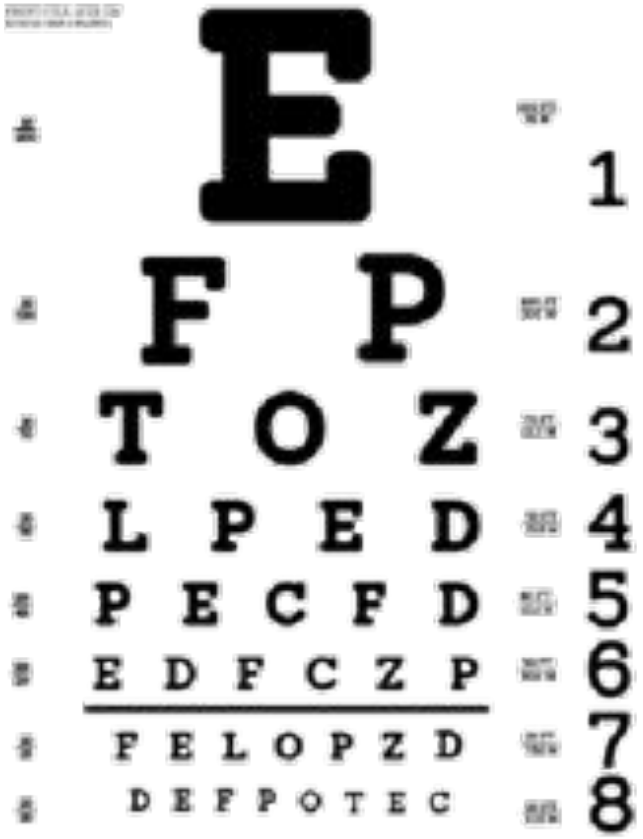
Observation blurs the truth and adds noise

Image



Data = Image ✻ PSF + Noise

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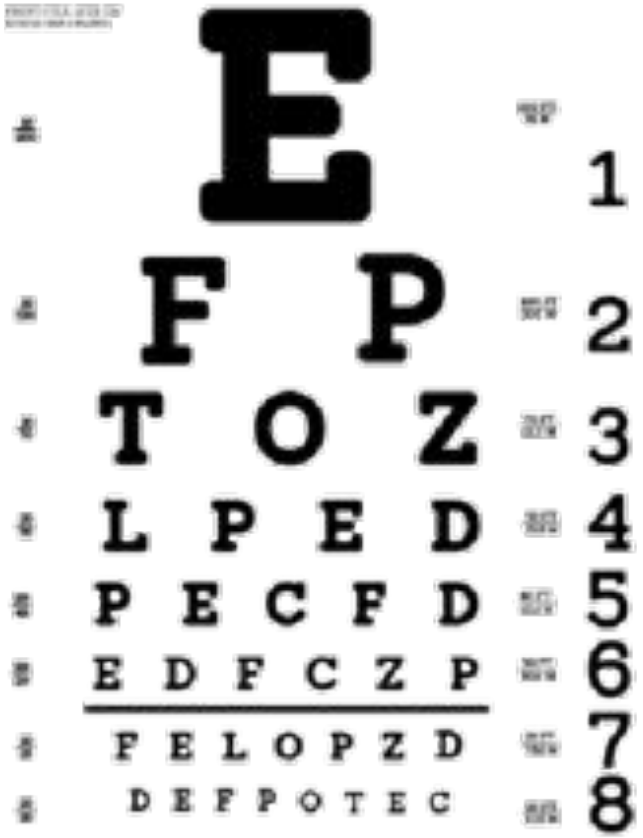
Reconstruction suppresses noise and sharpens the data

Image

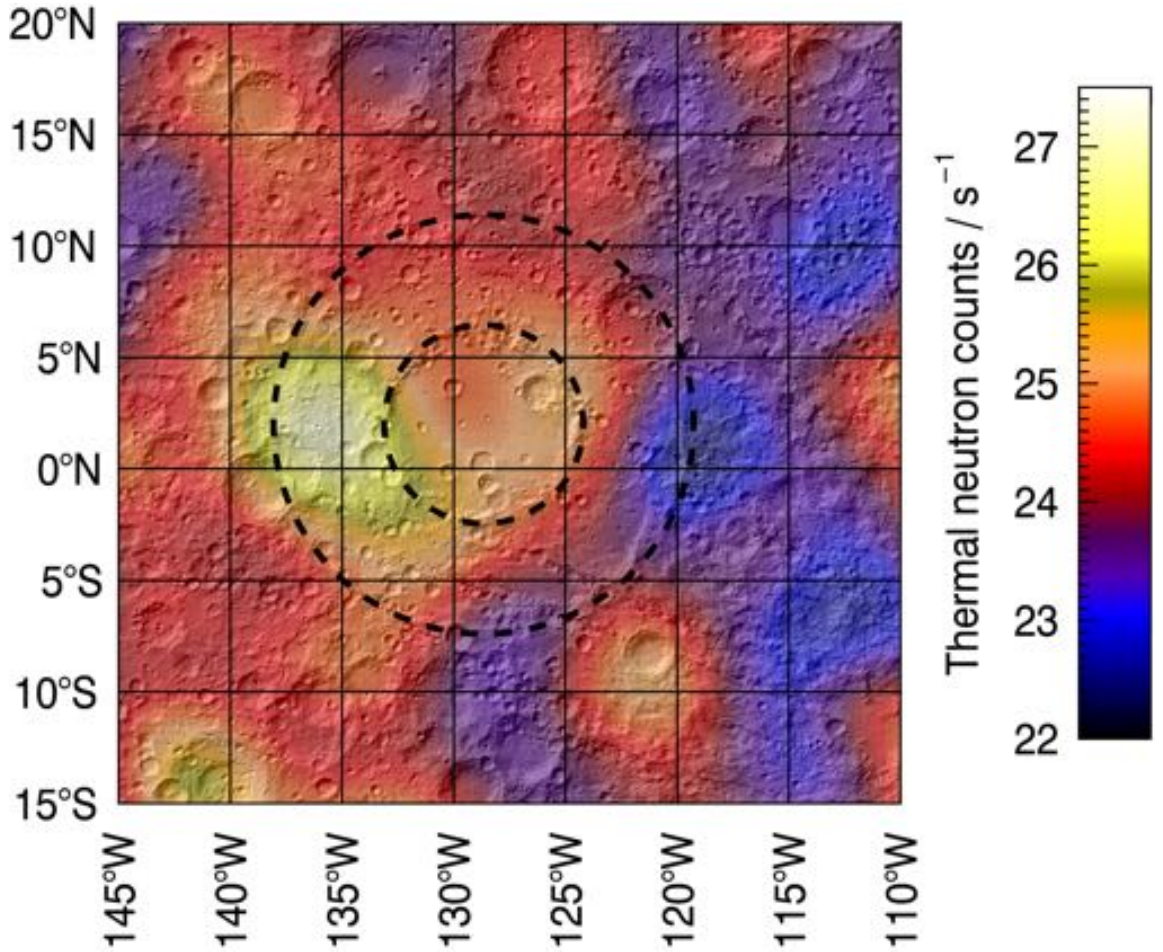


Data = Image ✻ PSF + Noise

Reconstruction

Reconstruction increased the dynamic range by 66% and suppressed noise

- Improvement in resolution and reduction in noise shows high thermal region between inner and outer ring.



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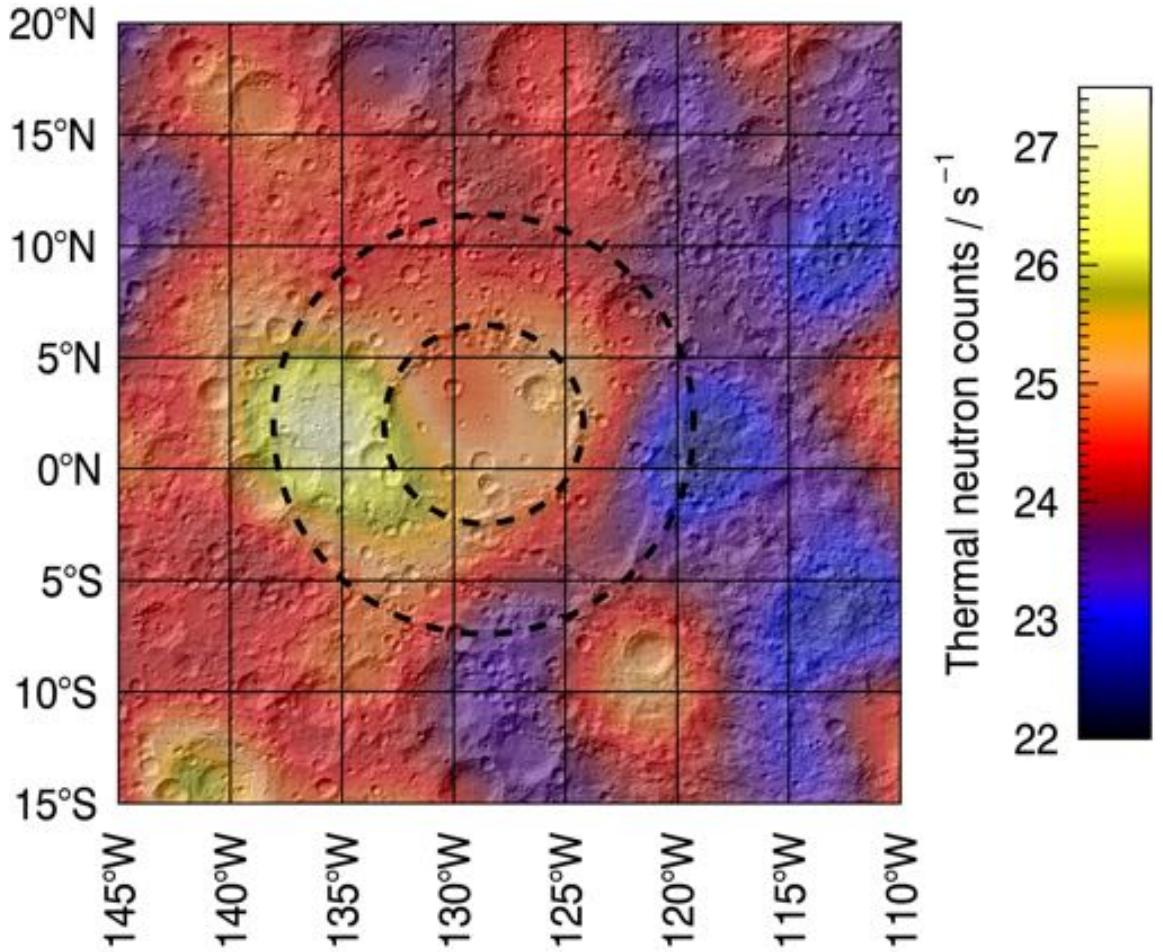
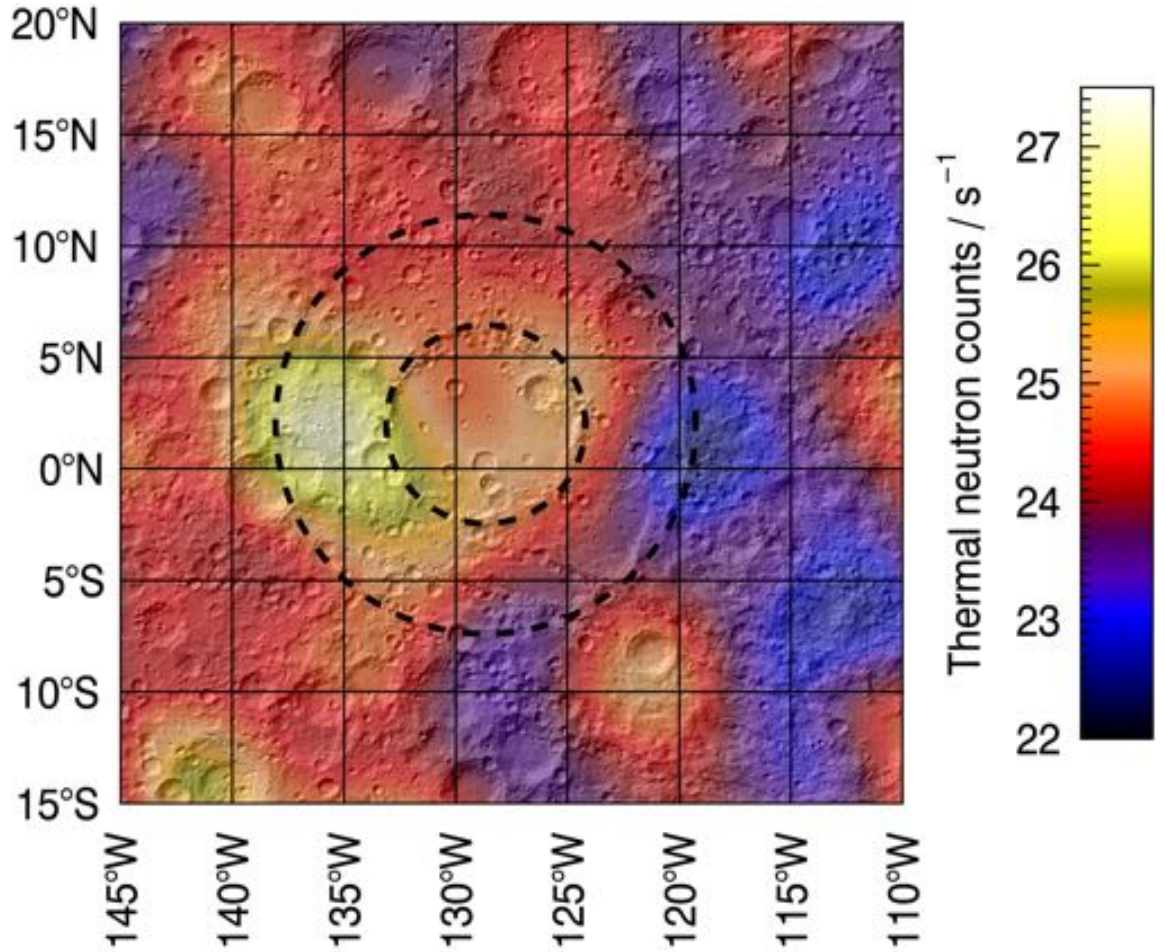
Hertzsprung's inter ring region contains nearly pure (>95 %) anorthosite abundances over a region 100 km diameter

- Basin floor landing site avoids steep peak rings and craters where PAN is identified spectroscopically.
- Extremely low REE abundances imply a large sample will be needed for composition analysis.

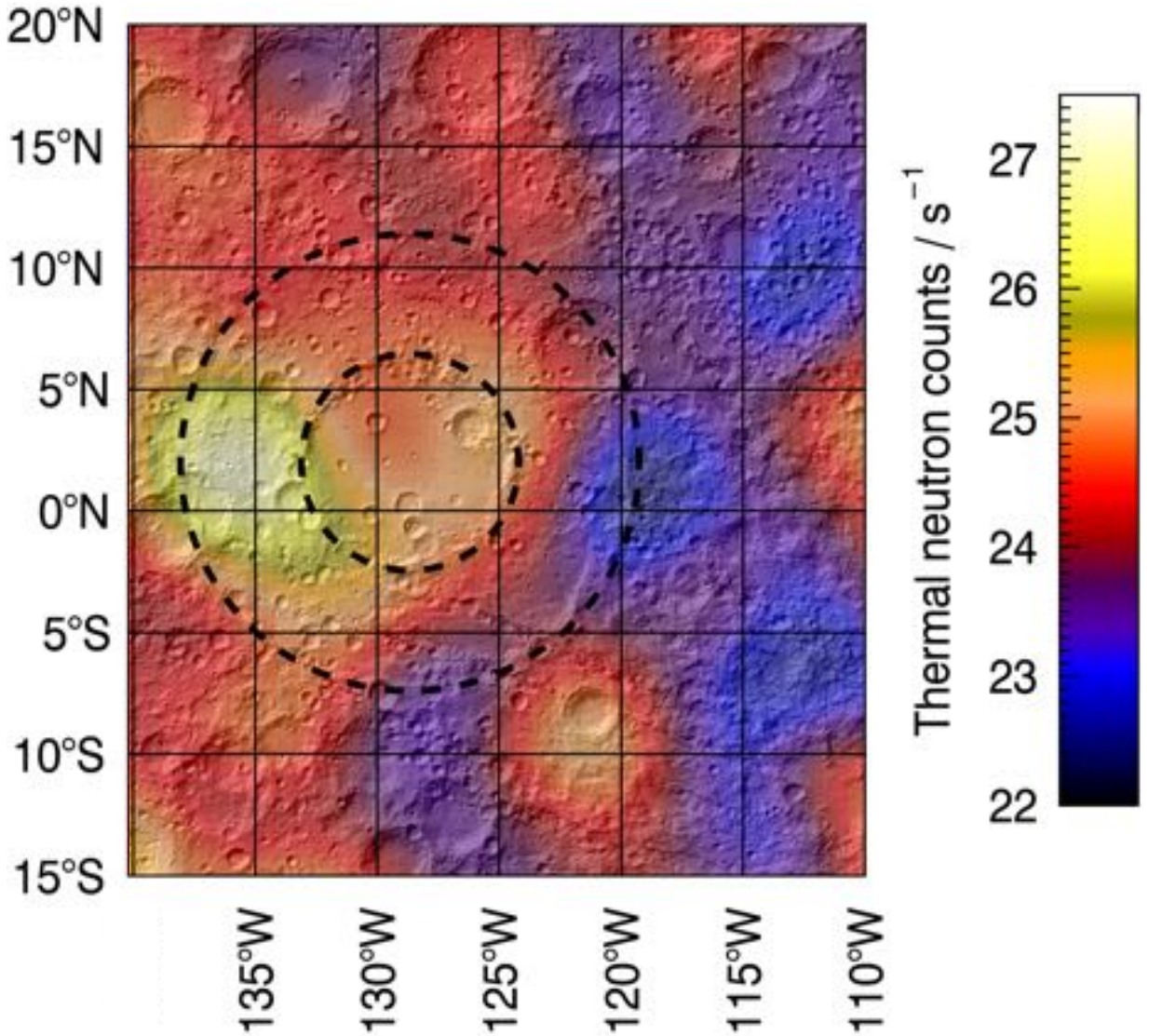


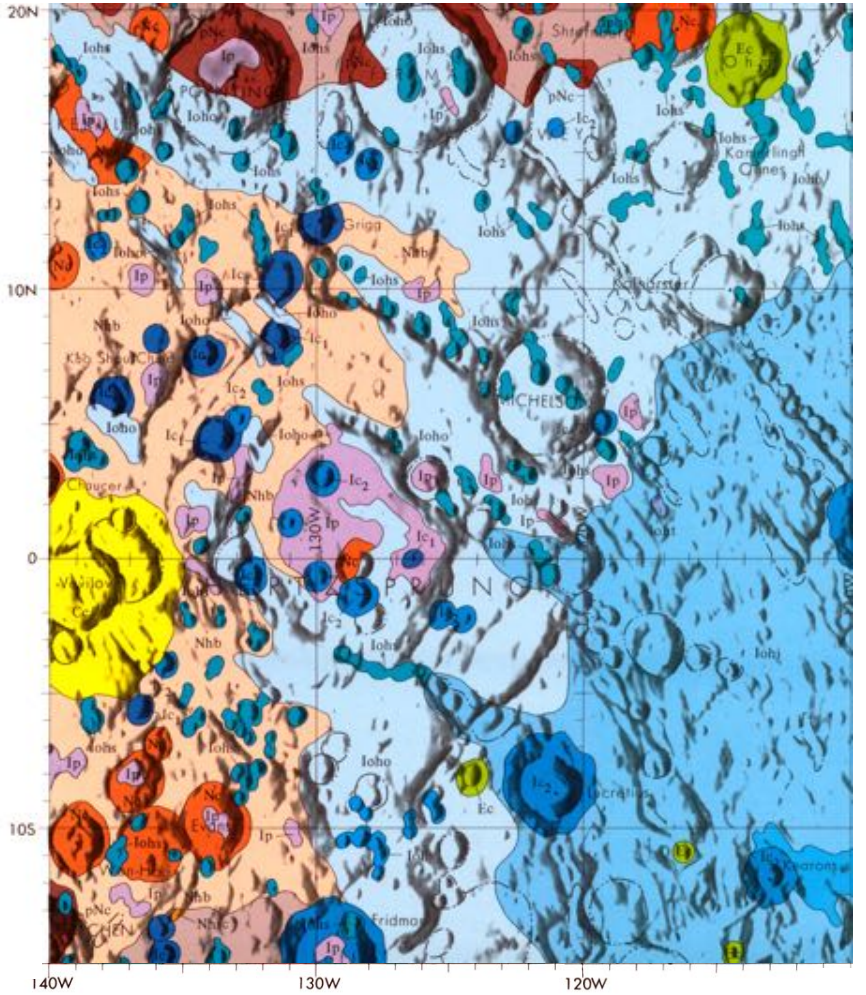
Science Goals addressed by Hertzsprung PAN characterization

1. Determine the composition of the lower crust and bulk Moon (3c).
2. Determine the extent and composition of the primary feldspathic crust (3*a*).



Nearby Orientale ejecta and impact melts provide an incentive for a rover





Scott, D. H. et al., USGS, 1977

Conclusions

- LP thermal neutron along with Selene spectral profiler, Clementine FeO and albedo data imply that a large (100 km) easily accessible region of PAN lies within Hertzsprung basin.
- Given the low concentrations of the elements of interest the return of a large sample may be necessary, but a rover is not.